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Fluctuation in Lower Stem Nitrate Concentration in Small Grains

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Summary

Lower stem nitrate concentration is used as a guide for fertilization of small grains in Arizona. The objective of this study is to determine if the timing of stem sampling has an appreciable effect on stem nitrate and corresponding fertilizer recommendations. Durum and barley were grown at the Maricopa Agricultural Center and lower stems were analyzed for nitrate from 3-leaf to maturity. Stem nitrate concentration varied considerably between the 3-leaf and 2 node stages, but thereafter was relatively constant and low (averaged 765 ppm). Stem nitrate increased after rain or N application on a few occasions, but not consistently. In this study, the timing of the stem sampling could have affected fertilizer recommendations before the 2-node stage, but after the 2-node stage, fluctuations in stem nitrate would have resulted in relatively minor differences in fertilizer recommendations.

Introduction

The lower stem nitrate concentration is used as a guide for fertilization for small grains in Arizona. In the 2002-2003 growing season, we developed guidelines for the use of the lower stem nitrate test at heading for achieving adequate grain protein concentration. Since these guidelines were released, questions about the fluctuation of lower stem nitrate between irrigations have arisen. The objective of this study is to document fluctuation in lower stem nitrate concentration during the season to answer the question of whether or not the timing of the stem sample is critical.

Procedures

Durum (Duraking) and barley (Baretta) were planted on December 3, 2003 at the Maricopa Agricultural Center on a sandy clay loam soil. The plots were 42 ft by 40 ft in size and replicated twice in blocks. Preplant fertilizer included 48 lbs N/acre and 60 lbs P_2O_5/acre as 16-20-0. Irrigations were applied on Dec. 3, Jan. 29, Mar. 1, Mar. 18, Apr. 1, Apr. 16, and Apr. 30. Dates and amounts of rainfall are: Jan 21 (0.16'), Jan 22 (0.24"), Jan 23 (0.28"), Jan 24 (0.04"), Feb 23 (0.79"), Feb 24 (0.12"), Mar 2 (0.12"), Mar 3 (0.06"), Mar 5 (0.12"), Apr 2 (0.24"), and Apr 4 (0.75"). Urea was broadcast and incorporated with irrigation water at a rate of 23 lbs N/acre on Jan. 29, 55 lbs N/acre on Mar. 1, 46 lbs N/acre on Mar. 18, and 46 lbs N/acre on Apr. 1 for a seasonal N application of 218 lbs N/acre. The lower portion of the stem was sampled about twice per week from the 3-leaf stage until maturity. The portion of the lower stem between the seed and the soil surface was sampled until Feb 19, and after this date, the 2 inches of the stem above the soil surface was sampled. Heading occurred on Mar 15 (Baretta) and Mar 22 (Duraking) and maturity occurred on Apr 25 (Baretta) and Apr 30 (Duraking). The stem samples were oven dried, ground to pass through a 1mm screen, and analyzed for nitrate using the Griess-Ilosvay method. Differences between stem nitrate concentration of varieties were analysed using a completely randomized design.

Results and Discussion

The lower stem nitrate concentration was initially in the 3000 to 5000 ppm range from the 3-leaf to 1-node stage, fell precipitously between the 1-node and 2-node stages, and averaged 765 ppm from the 2-node stage until maturity (Fig. 1, Table 1). A more gradual decline in stem nitrate concentration without fluctuations is preferable. The decrease in stem nitrate between the 3-leaf and 5-leaf stages can be explained by crop growth during this period. The increase in stem nitrate concentration shortly after the 5-leaf stage may have been related to precipitation releasing N from the soil or allowing renewed nutrient uptake from a previously dry surface soil layer. The sharp drop in stem nitrate concentration between the 1-node and 2-node stages may be related to the rapid growth and nutrient uptake during this period. Irrigation and nitrogen fertilization at about the 6-leaf stage did not prevent this drop in stem nitrate. Nitrogen fertilizer application resulted in a slight increase in stem nitrate concentration in early and mid-March after the 2-node stage, but a similar result was not obtained in early April between heading and milk. While precipitation around the 5-leaf stage may have resulted in an increase in stem nitrate, precipitation at other times appear to have little of no effect. The stem nitrate concentration of the two varieties followed the same general pattern over the season, but stem nitrate of the barley was higher on Jan 29 around the 6-leaf stage and lower at several sampling times from mid-Feb to mid-Mar between the 1-node stage and heading. The fluctuation in stem nitrate between the 3-leaf and 2-node stages was extreme enough to affect nitrogen fertilizer recommendations, but the fluctuations in stem nitrate after the 2-node stage were relatively minor or not statistically significant. A difference of 500 ppm at heading would result in a difference in recommended N after heading of 7.5 to 15 lbs N/acre depending on whether or not stem nitrate is above or below 1000 ppm.

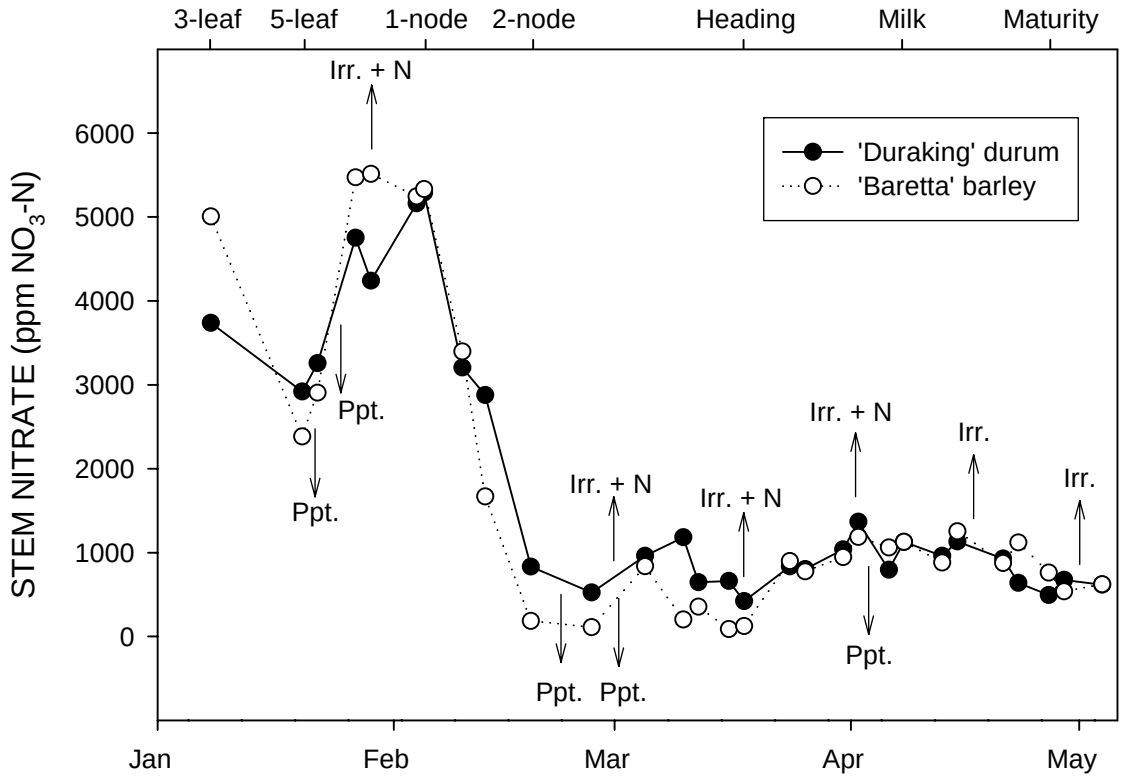

Fig. 1. Stem nitrate concentration of 'Duraking' durum and 'Baretta' barley during the season. "Irr" is an abbreviation for irrigation, "N" refers to 23 lbs N/acre on Jan. 29, 55 lbs N/acre on Mar. 1, 46 lbs N/acre on Mar. 18, and 46 lbs N/acre on Apr. 1, and "Ppt" is an abbreviation for precipitation or rainfall.

Table 1. Stem nitrate concentration of 'Duraking' durum and 'Baretta' barley during the season.

	Stem nitrate		
Date	Duraking	Baretta	Significant*
	ppm NO_3-N		
01/08/04	3737	5005	No
01/20/04	2918	2383	No
01/22/04	3257	2906	No
01/27/04	4753	5471	No
01/29/04	4240	5514	Yes
02/04/04	5161	5243	No
02/05/04	5288	5333	No
02/10/04	3205	3397	No
02/13/04	2878	1670	No
02/19/04	833	186	Yes
02/27/04	525	111	Yes
03/05/04	960	836	No
03/10/04	1182	202	Yes
03/12/04	647	355	Yes
03/16/04	661	87	No
03/18/04	422	125	No
03/24/04	834	899	No
03/26/04	804	775	No
03/31/04	1039	946	No
04/02/04	1367	1186	No
04/06/04	797	1060	No
04/08/04	1127	1128	No
04/13/04	961	881	No
04/15/04	1132	1253	No
04/21/04	928	877	No
04/23/04	638	1121	No
04/27/04	494	761	No
04/29/04	676	538	No
05/04/04	617	622	No

* Significant refers to whether or not the stem nitrate concentration of the varieties are statistically different at the 10% probability level. The least significant difference (5% probability level) for comparing stem nitrate concentration at differing dates is 466 ppm.